## CLAIMS

**1.** A method of disseminating location information wherein location data items originating
at known locations are passed to, and diffused between, entities by short-range
communication, each location data item including a distance-related quantity indicative of
an upper bound value for the distance travelled by the location data item from a specified
said known location, said entities updating the distance-related quantities of location data
items they handle to take account of perceived travel of these location data items.

**2.** A method according to claim 1, wherein a said entity, which is a mobile entity,
increases the distance-related quantity of the or each location data item it handles by an
amount corresponding to the distance moved by the entity whilst holding the location data
item.

**3.** A method according to claim 2, wherein the mobile entity is a vehicle equipped with a
short-range transceiver and an odometer, the vehicle increasing the distance-related
quantity of its location data items by the distance travelled by the vehicle as indicated by
said odometer.

**4.** A method according to claim 2, wherein the mobile entity is a pedestrian carrying a
mobile device with a short-range transceiver, the device effecting an estimate of the
maximum distance likely to have been travelled by the pedestrian based on a speed value
and elapsed time, and the device increasing the distance-related quantity of its location
data items by said estimate of the maximum distance likely to have been travelled by the
pedestrian.

**5.** A method according to claim 4, wherein said speed is the maximum speed of the
pedestrian as judged over time by the device based on the time taken for the pedestrian to
move between locations as determined by the location determination operation.

**6.** A method according to claim 4, wherein said speed is a standard maximum speed for walking pedestrians, the device:

- monitoring the current speed of the pedestrian based on the time taken for the pedestrian to move between locations of known position, and

5 - in the event of the current speed of the pedestrian exceeding said standard maximum speed, preventing the passing on of location data items from the mobile entity to other said entities.

**7.** A method according to claim 1, wherein the distance-related quantity of a said location

10 data item is increased, for each transmission hop between two entities, by an amount related to the transmission range of the transmitting entity.

**8.** A method according to claim 7, wherein the increase of said distance-related quantity is a fixed range value for the transmitting entity, this range value being added by the

15 transmitting entity to said distance-related quantity.

**9.** A method according to claim 7, wherein the said distance-related quantity incorporates a hop count for providing a measure of the distance travelled by the location data item concerned as a result of transmission hops.

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**10.** A method according to claim 7, wherein the increase of said distance-related quantity is a fraction of a range value for the transmitting entity, this fraction being determined by the receiving entity in dependence on the received signal strength, the receiving entity adjusting said distance-related quantity accordingly.

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**11.** A method according to claim 1, wherein a said entity, which is a mobile entity, increases the distance-related quantity of the or each location data item it handles both by an amount corresponding to the distance moved by the entity whilst holding the location data item and by an amount related to the transmission range of the transmitting entity in

30 respect of one of receipt and transmission of the location data item by mobile entity.

**12.** A method according to claim 1, wherein a said entity determines its location by determining a location simultaneously consistent, or most nearly consistent, with the upper bound values it knows of as a result of location data items it has received.

5 **13.** A method according to claim 12, wherein said entity in determining its location, applies one or more route constraints for how the location data items passed to the mobile entity.

**14.** A method according to claim 13, wherein said entity in determining its location, 10 applies a constraint that the said upper bound values are distances along predetermined routes from the known locations concerned.

**15.** A method according to claim 14, wherein said predetermined routes are routes on a map represented by map data known to the entity.

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**16.** A method according to claim 13, wherein said entity in determining its location applies a constraint that the said upper bound values are distances along indeterminate routes that avoid particular zones.

20 **17.** A method according to claim 13, wherein a received location data item includes an indication of a constraint type to be applied over at least a certain length of the associated upper bound distance value.

**18.** A method according to claim 12, wherein upon said entity receiving a location data 25 item indicating an upper bound distance value to a known location for which a location data item has been previously received, one of the location data items is discarded, the discarded item being the one indicating the larger upper bound distance value to the known location taking account of any increases due to movement of the entity after item receipt.

30 **19.** A method according to claim 12, wherein upon location determination by said entity initially indicating multiple location zones where the entity could be located, the entity seeks to determine which location zone is the most probable on the basis of one or more of

the following probability indicators:

- the size of the location zones as compared with an expected degree of location uncertainty;

- the natures of the routes followed in order to arrive at the location zones from the known locations involved;

- a previous history of locations visited or passed through by the entity;

- the correspondence of sensed travel events, such as turning, with opportunities for such events along routes to the location zones.

**20.** A method according to claim 12, wherein the location of said entity is determined on two separate occasions with the later determination using location data received after the first determination whereby to enable an indication of the average direction of travel to be derived.

**21.** A method according to claim 12, wherein a best estimate of location is derived within an area of possible locations based on an averaging relative to vertices of that area.

**22.** A method according to claim 21, wherein said estimate is carried out by averaging of coordinate values of said vertices.

**23.** A method according to claim 21, wherein said estimate is carried out by finding the center of gravity of a polygon delimited by said vertices.

**24.** A method according to claim 2, wherein a said entity determines its location by determining a location simultaneously consistent, or most nearly consistent, with the upper bound values it knows of as a result of location data items it has received.

**25.** A method according to claim 24, wherein said entity in determining its location, applies one or more route constraints for how the location data items passed to the mobile entity.

**26.** A method according to claim 25, wherein said entity in determining its location, applies a constraint that the said upper bound values are distances along predetermined routes from the known locations concerned.

5 **27.** A method according to claim 26, wherein said predetermined routes are routes on a map represented by map data known to the entity.

**28.** A method according to claim 25, wherein said entity in determining its location applies a constraint that the said upper bound values are distances along indeterminate routes that
10 avoid particular zones.

**29.** A method according to claim 25, wherein a received location data item includes an indication of a constraint type to be applied over at least a certain length of the associated upper bound distance value.
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**30.** A method according to claim 24, wherein upon said entity receiving a location data item indicating an upper bound distance value to a known location for which a location data item has been previously received, one of the location data items is discarded, the discarded item being the one indicating the larger upper bound distance value to the known
20 location taking account of any increases due to movement of the entity after item receipt.

**31.** A method according to claim 24, wherein upon location determination by said entity initially indicating multiple location zones where the entity could be located, the entity seeks to determine which location zone is the most probable on the basis of one or more of
25 the following probability indicators:
- the size of the location zones as compared with an expected degree of location uncertainty;
- the natures of the routes followed in order to arrive at the location zones from the known locations involved;
30 - a previous history of locations visited or passed through by the entity;
- the correspondence of sensed travel events, such as turning, with opportunities for such events along routes to the location zones.

**32.** A method according to claim 24, wherein the location of said entity is determined on two separate occasions with the later determination using location data received after the first determination whereby to enable an indication of the average direction of travel to be derived.

**33.** A method according to claim 24, wherein a best estimate of location is derived within an area of possible locations based on an averaging relative to vertices of that area.

**34.** A method according to claim 33, wherein said estimate is carried out by averaging of coordinate values of said vertices.

**35.** A method according to claim 33, wherein said estimate is carried out by finding the center of gravity of a polygon delimited by said vertices.

**36.** A method according to claim 7, wherein a said entity determines its location by determining a location simultaneously consistent, or most nearly consistent, with the upper bound values it knows of as a result of location data items it has received.

**37.** A method according to claim 36, wherein said entity in determining its location, applies one or more route constraints for how the location data items passed to the mobile entity.

**38.** A method according to claim 37, wherein said entity in determining its location, applies a constraint that the said upper bound values are distances along predetermined routes from the known locations concerned.

**39.** A method according to claim 38, wherein said predetermined routes are routes on a map represented by map data known to the entity.

**40.** A method according to claim 37, wherein said entity in determining its location applies a constraint that the said upper bound values are distances along indeterminate routes that avoid particular zones.

5   **41.** A method according to claim 37, wherein a received location data item includes an indication of a constraint type to be applied over at least a certain length of the associated upper bound distance value.

**42.** A method according to claim 36, wherein upon said entity receiving a location data
10   item indicating an upper bound distance value to a known location for which a location data item has been previously received, one of the location data items is discarded, the discarded item being the one indicating the larger upper bound distance value to the known location taking account of any increases due to movement of the entity after item receipt.

15   **43.** A method according to claim 36, wherein upon location determination by said entity initially indicating multiple location zones where the entity could be located, the entity seeks to determine which location zone is the most probable on the basis of one or more of the following probability indicators:

-   the size of the location zones as compared with an expected degree of location
20      uncertainty;

-   the natures of the routes followed in order to arrive at the location zones from the known locations involved;

-   a previous history of locations visited or passed through by the entity;

-   the correspondence of sensed travel events, such as turning, with opportunities for
25      such events along routes to the location zones.

**44.** A method according to claim 36, wherein the location of said entity is determined on two separate occasions with the later determination using location data received after the first determination whereby to enable an indication of the average direction of travel to be
30   derived.

**45.** A method according to claim 36, wherein a best estimate of location is derived within

an area of possible locations based on an averaging relative to vertices of that area.

**46.** A method according to claim 45, wherein said estimate is carried out by averaging of coordinate values of said vertices.

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**47.** A method according to claim 45, wherein said estimate is carried out by finding the center of gravity of a polygon delimited by said vertices.

**48.** A location discovery method in which an entity :

10 - receives location data items from currently-nearby transmitting entities, each location data item including a distance-related quantity indicative of an upper bound distance to a specified known location;

- maintains the received location data items by updating the distance-related quantity of each location data item to take account of perceived travel of the location data

15 items; and

- effects location determination by determining what locations are simultaneously consistent, or most nearly consistent, with the upper bound distances known to the entity.

20 **49.** A method according to claim 48, wherein said entity, which is a mobile entity, maintains the location data items it has received by increasing the distance-related quantity of the or each location data item by an amount corresponding to the distance moved by the entity whilst holding the location data item.

25 **50.** A method according to claim 49, wherein the mobile entity is a vehicle equipped with a short-range transceiver and an odometer, the vehicle increasing the distance-related quantity of its location data items by the distance travelled by the vehicle as indicated by said odometer.

30 **51.** A method according to claim 49, wherein the mobile entity is a pedestrian carrying a mobile device with a short-range transceiver, the device effecting an estimate of the maximum distance likely to have been travelled by the pedestrian based on a speed value

and elapsed time, and the device increasing the distance-related quantity of its location data items by said estimate of the maximum distance likely to have been travelled by the pedestrian.

5    **52.** A method according to claim 51, wherein said speed is the maximum speed of the pedestrian as judged over time by the device based on the time taken for the pedestrian to move between locations as determined by the location determination operation.

**53.** A method according to claim 51, wherein said speed is a standard maximum speed for
10    walking pedestrians, the device:

-    monitoring the current speed of the pedestrian based on the time taken for the pedestrian to move between locations of known position, and

-    in the event of the current speed of the pedestrian exceeding said standard maximum speed, preventing the passing on of location data items from the mobile entity to
15    other said entities.

**54.** A method according to claim 48, wherein said entity maintains the location data items it has received by increasing the distance-related quantity of a said location data by an amount related to the transmission range of the transmitting entity in respect of one of
20    receipt and transmission of the location data item by entity.

**55.** A method according to claim 54, wherein said entity increases the distance-related quantity of a location data item immediately prior to the entity transmitting that item to another entity, this increase being by a fixed transmission range value.

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**56.** A method according to claim 54, wherein said entity increases the distance-related quantity of a location data item received from another entity by a fraction of a range value for the transmitting entity, this fraction being determined by the receiving entity in dependence on the received signal strength.

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**57.** A method according to claim 48, wherein said entity, on encountering another entity, passes on its previously-received location data items to that other entity after updating the distance-related quantities associated with these items.

5 **58.** A method according to claim 48, wherein said entity in determining its location, applies one or more route constraints for how the location data items passed to the mobile entity.

**59.** A method according to claim 58, wherein said entity in determining its location, 10 applies a constraint that the said upper bound distances are distances along predetermined routes from the known locations concerned.

**60.** A method according to claim 58, wherein said entity in determining its location applies a constraint that the said upper bound distances are distances along indeterminate routes 15 that avoid particular zones.

**61.** A method according to claim 48, wherein a best estimate of location is derived within an area of possible locations based on an averaging relative to vertices of that area.

20 **62.** A method according to claim 49, wherein said entity, on encountering another entity, passes on its previously-received location data items to that other entity after updating the distance-related quantities associated with these items.

**63.** A method according to claim 49, wherein said entity in determining its location, 25 applies one or more route constraints for how the location data items passed to the mobile entity.

**64.** A method according to claim 63, wherein said entity in determining its location, applies a constraint that the said upper bound distances are distances along predetermined 30 routes from the known locations concerned.

**65.** A method according to claim 63, wherein said entity in determining its location applies a constraint that the said upper bound distances are distances along indeterminate routes that avoid particular zones.

5    **66.** A method according to claim 49, wherein a best estimate of location is derived within an area of possible locations based on an averaging relative to vertices of that area.

**67.** A method according to claim 54, wherein said entity, on encountering another entity, passes on its previously-received location data items to that other entity after updating the
10    distance-related quantities associated with these items.

**68.** A method according to claim 54, wherein said entity in determining its location, applies one or more route constraints for how the location data items passed to the mobile entity.
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**69.** A method according to claim 68, wherein said entity in determining its location, applies a constraint that the said upper bound distances are distances along predetermined routes from the known locations concerned.

20    **70.** A method according to claim 68, wherein said entity in determining its location applies a constraint that the said upper bound distances are distances along indeterminate routes that avoid particular zones.

**71.** A method according to claim 54, wherein a best estimate of location is derived within
25    an area of possible locations based on an averaging relative to vertices of that area.

**72.** A mobile entity provided with a location discovery system comprising:
- a short-range receiver for receiving location data items from currently nearby transmitting entities, each location data item concerning an upper bound distance to a
30      known location;
- a memory for storing the received data items;

- a distance sub-system for measuring or estimating the distance travelled by the mobile entity;

- an update unit for updating the received data items by increasing the upper bound distance associated with each data item by the distance measured or estimated by

5    the distance sub-system since the item concerned was received or last updated; and

- a location determination unit operative to determine what locations are simultaneously consistent, or most nearly consistent, with the upper bound distances known to the mobile entity.

10   **73.** An entity provided with a location discovery system comprising:

- a short-range receiver for receiving location data items from currently nearby transmitting entities, each location data item concerning an upper bound distance to a known location;

- a memory for storing the received data items;

15   - an update unit for updating the received data items by increasing the upper bound distance associated with each data item by an amount related to the transmission range of the transmitting entity in respect of one of receipt and transmission of the location data item by the entity; and

- a location determination unit operative to determine what locations are

20    simultaneously consistent, or most nearly consistent, with the upper bound distances known to the mobile entity.

**74.** A location discovery method wherein location data items originating at known locations are passed to, and diffused between, mobile entities by short-range

25   communication, each location data item received by a mobile entity indicating a maximum distance of the entity from a said known location, and each mobile entity prior to using a location data item for location determination or transferring it to another mobile entity, increasing the maximum distance indicated by the location data item to take account of movement of the mobile entity since receiving that item, the mobile entity effecting

30   location determination by finding locations simultaneously consistent with the maximum distances it knows of and any applicable route constraints for how the location data items passed to the mobile entity.

**75.** A location discovery method in which a mobile entity :

- receives location data items from currently-nearby transmitting entities, each location data item concerning a maximum distance to a known location;

5 - maintains the received data items by increasing the maximum distance associated with each data item by the actual or estimated movement of the mobile entity; and

- effects location determination by determining what locations are simultaneously within all the maximum distances known to the mobile entity and satisfy any other constraints applied by the mobile entity.

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**76.** A method according to claim 75, wherein the mobile entity, on encountering another mobile entity, passes on its previously-received location data items to the other mobile entity, the maximum distances associated with these items having been increased to take account of the actual or estimated movement of the mobile entity passing them on.

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**77.** A method according to claim 75, wherein the mobile entity is a vehicle equipped with a short-range transceiver and an odometer, the vehicle increasing the maximum distances of its location data items by the distance travelled by the vehicle as indicated by said odometer.

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**78.** A method according to claim 76, wherein the mobile entity is a vehicle equipped with a short-range transceiver and an odometer, the vehicle increasing the maximum distances of its location data items by the distance travelled by the vehicle as indicated by said odometer.

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**79.** A method according to claim 75, wherein the mobile entity is a pedestrian carrying a mobile device with a short-range transceiver, the device effecting an estimate of the maximum distance likely to have been travelled by the pedestrian based on a speed value and elapsed time, and the device increasing the maximum distances of its location data items by said estimate of the maximum distance likely to have been travelled by the pedestrian.

**80.** A method according to claim 76, wherein the mobile entity is a pedestrian carrying a mobile device with a short-range transceiver, the device effecting an estimate of the maximum distance likely to have been travelled by the pedestrian based on a speed value and elapsed time, and the device increasing the maximum distances of its location data

5    items by said estimate of the maximum distance likely to have been travelled by the pedestrian.

**81.** A method according to claim 75, wherein the location determination operation applies a constraint that the said maximum distances are distances along predetermined routes

10   from the known locations concerned.

**82.** A method according to claim 75, wherein the location determination operation applies a constraint that the said maximum distances are distances along indeterminate routes that avoid particular zones.

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**83.** A mobile entity provided with a location discovery system comprising:

-    a short-range receiver for receiving location data items from currently nearby transmitting entities, each location data item concerning a maximum distance to a known location;

20   -    a memory for storing the received data items;

-    a distance sub-system for measuring or estimating the distance travelled by the mobile entity;

-    an update unit for updating the received data items by increasing the maximum distance associated with each data item by the distance measured or estimated by

25        the distance sub-system since the item concerned was received or last updated; and

-    a location determination unit operative to determine what locations are simultaneously within all the maximum distances known to the mobile entity and satisfy and any other constraints applied by the mobile entity.

30   **84.** A method of disseminating location information, wherein location data, including a component indicative of distance from a particular location, is passed between devices by short-range transceivers, said distance component of the location data being increased, for

each transmission hop between two devices, by an amount related to the transmission range
of the transmitting device.